Grid Reliability and Renewable Energy

Science, Technology and Telecommunications Committee

Presented by Dr. Dennis Morrison

New Mexico Tech

November 9, 2012

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Grid Reliability and Renewable Energy (Funding)

DOE	$3,278,000
NM Programs used as Cost Share	
NM Hydrogen Initiative	$ 344,811
Internal NMT funds	$ 191,043
Overhead credit	$ 24,400
Private Sector Participation	
EMCORE	$ 257,401
Total	$4,095,655

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Grid Reliability and Renewable Energy (Research Elements, 1)

- **Microgrid Reliability, Instrumentation and Testing (Emphasis of this Presentation)**
- **Microgrid Reliability Modeling**
- **Challenges in Developing Renewable Distributed Energy Resources**
- **Biomass to Hydrogen Reforming Nanoclay based Membranes and Electrodes for Fuel Cells Plasma Surface Modification of Pt-Carbon Supports Novel Thick Film**
- **Microstructures for Dye Sensitized Photovoltaic Cells**

Grid Reliability and Renewable Energy (Research Elements, 2)

- **N-Aryl Arenecarboximides as Panchromatic Dyes for DSSC Applications**
- **Biomass/BioFuel Production using Algae**
- **Update - New Mexico Center for Energy Policy (NMCEP), Hobbs, New Mexico**
- **Design and Development of a Supercritical Biodiesel Reactor System**

Grid Reliability and Renewable Energy

http://www.emrtc.nmt.edu/

http://www.iera.nmt.edu/

http://www.ptrc-nmt.us/index.html

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Energy Research at Playas NM

Institute for Engineering Research and Applications,
Albuquerque, NM

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Project Goals

- Utilize the unique facilities at Playas, NM for the **retrofit** of distributed energy assets to **allow testing and evaluation** of advanced energy sources for **security and reliability** benefits.
- Further Instrument the Playas grid to characterize the installed distributed energy resources in terms of their capacity to reliably serve the separate **critical loads** and support the performance of the grid at large
- **Evaluate Next Generation** Solar PV Modules and Inverter Technology
- Design 2 intelligent home energy systems using next generation component, including inverter, energy storage Apply only the **newest technologies** and compare results.
- **Implement SCADA and Web based control** of PV solar power systems
- **Sub Meter 3 commercial buildings** using Web based 2 way communications
- More **secure** local energy supplies for critical infrastructure
- Increased **power quality** and/interface reduced outage costs to consumers

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About Playas Training and Research Center (PTRC)

- The Town site is owned by NMT and is 640 Acres
- Additional 1200 Acres Surround the Town
- 259 Single Family Homes (1300 ft2 – 3800 ft2)
- 25 Apartment Units
- Community Center, Day care and RV park
- Fire Station
- Fully Equipped Medical Clinic with Ambulance
- Airstrip (~5000 ft)
- Wide Streets with Street Lights
- Three Water Wells
- Elevated Water Storage Tank (200,000 gallons)
- Wastewater Treatment Plant
- Giga-bit Fiber Optic network installed at every building

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Playas Aerial View

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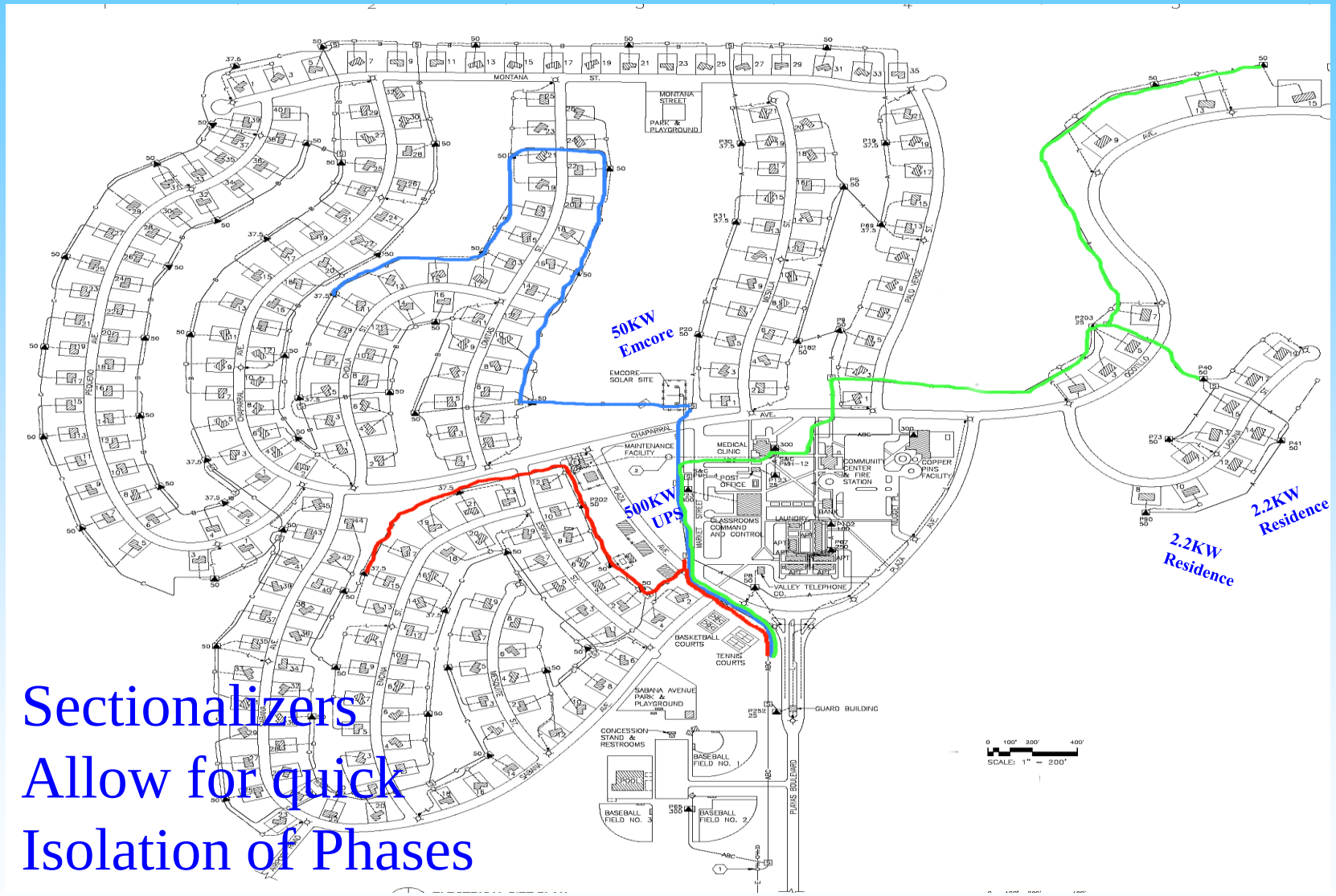
Electrical Diagram of Playas



Sectionalizers Allow for quick Isolation of Phases

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Playas Feeder at Sub Station

Old Analog Ink on Paper recorders
Will be updated with SCADA and
Remote 2 way communications

Measuring Power Draw from Playas at Feeder Connections

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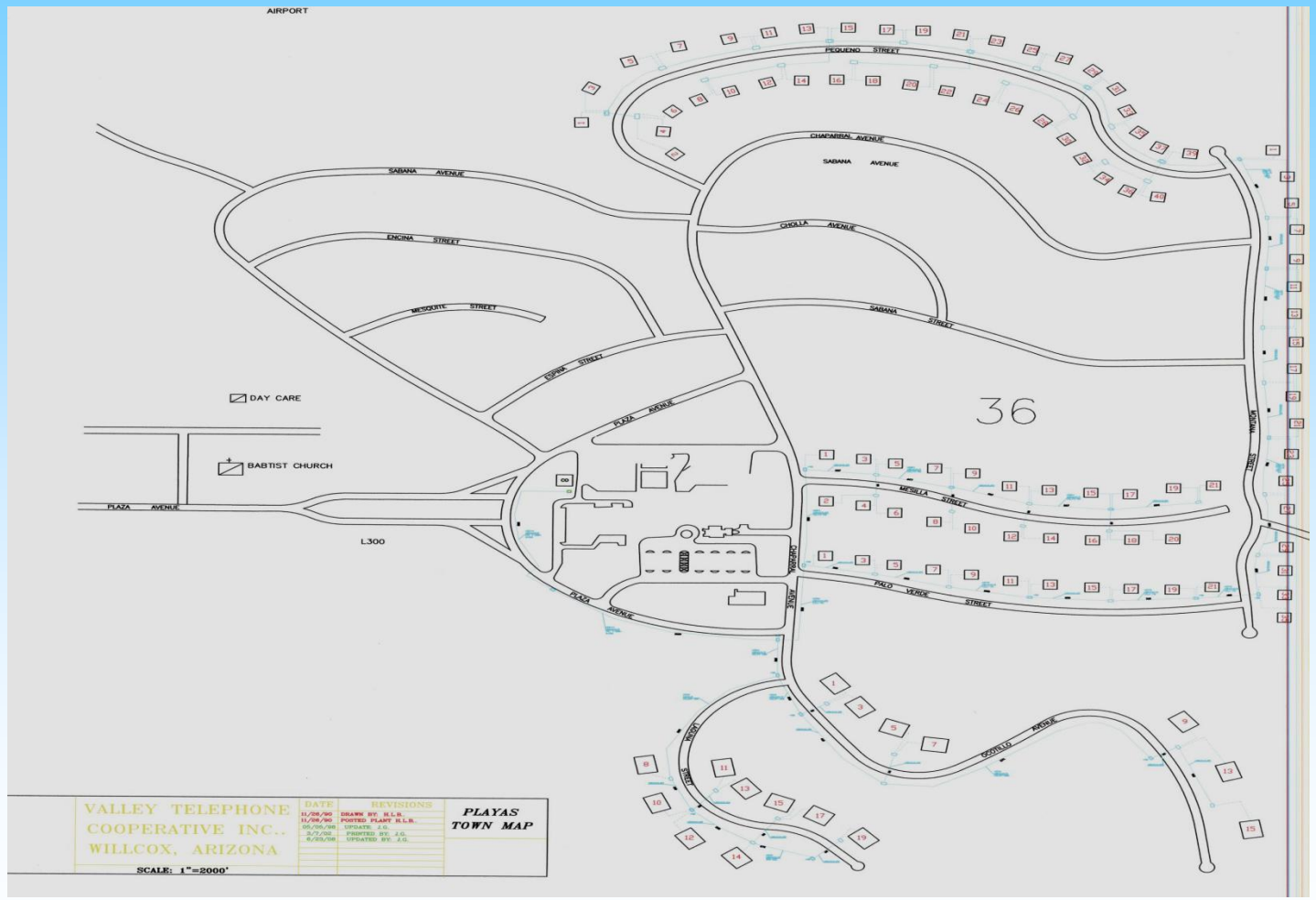
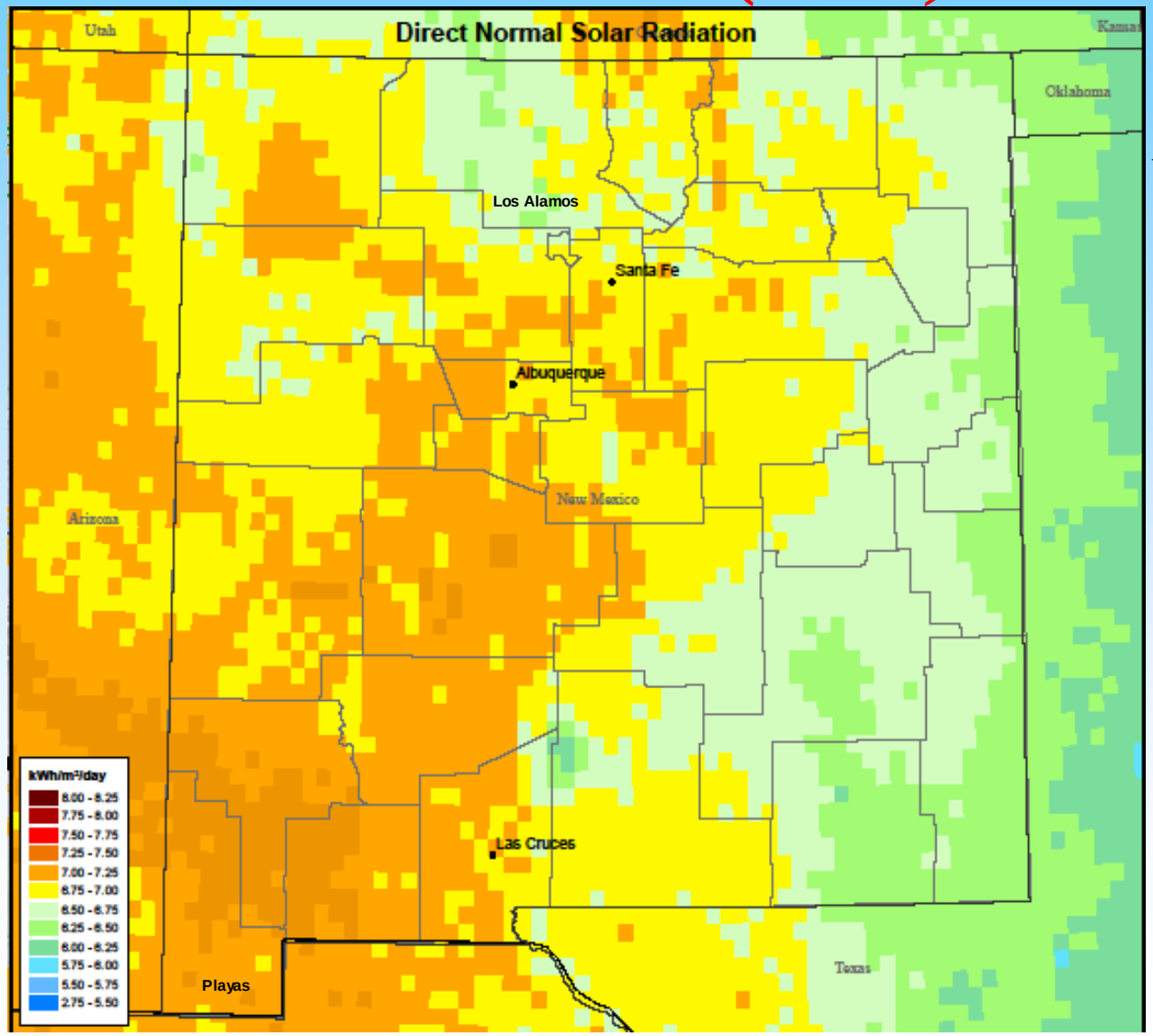
Fiber Optic Diagram of Playas



Playas has High Direct Normal Irradiation (DNI)



Playas 7.00-7.25

Albuquerque **6.75-7.00**

Los Alamos 6.50-6.75

kWh/m2/day

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Sub Meters installed at the 3 largest power consuming buildings

Ethernet or RS485 Communications

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2 Intelligent Home Energy Systems

- 2.2kW of PV Modules
- 4kW Smart Inverter
- 16 kWHrs Battery backup
- WEB Monitor and Controls
- Automatic and manual transfer switches

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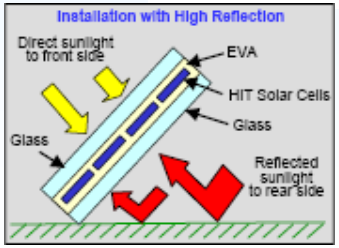
12 PV Modules with active trackers

SANYO HIT® Double
BIFACIAL PHOTOVOLTAIC MODULES

SANYO HIT PHOTOVOLTAIC MODULES



Cell Efficiency: 17.8% - 20.2%

Module Efficiency: 15.3% - 17.4%

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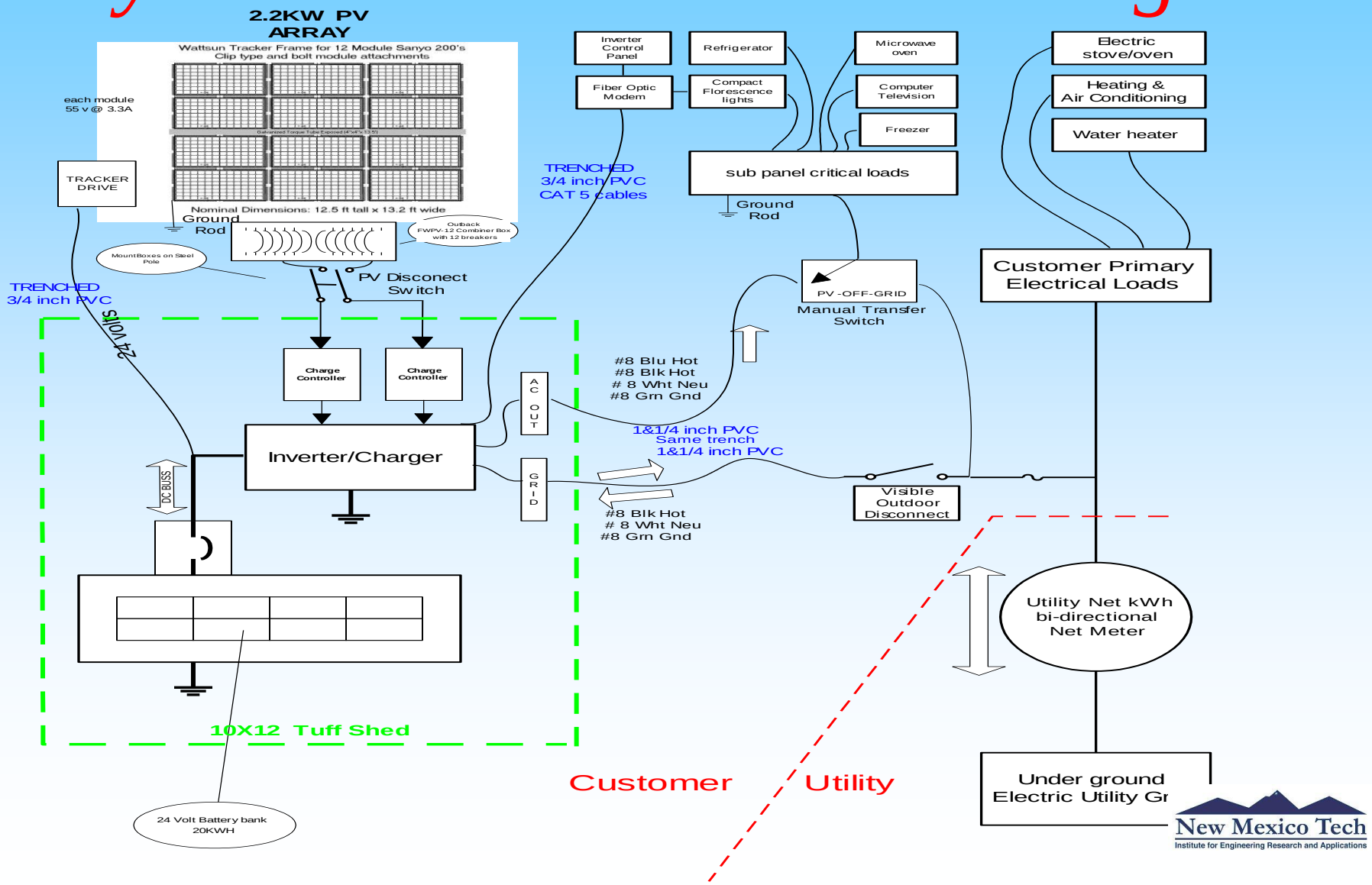
Residential battery backed PV system 4KW & 20KWH storage



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Residence # 10 Laguna

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Residence # 10 Laguna

Xantrex XW Hybrid Inverter/Charger

The NEXT generation inverter/charger for renewable energy systems and backup power applications

True sine wave inverter
95% efficient

Maximum Power Point Controller MPPT

Remote Control

Surrette

10 Year life
6Volts 350AH each
2 sets of 4 in series

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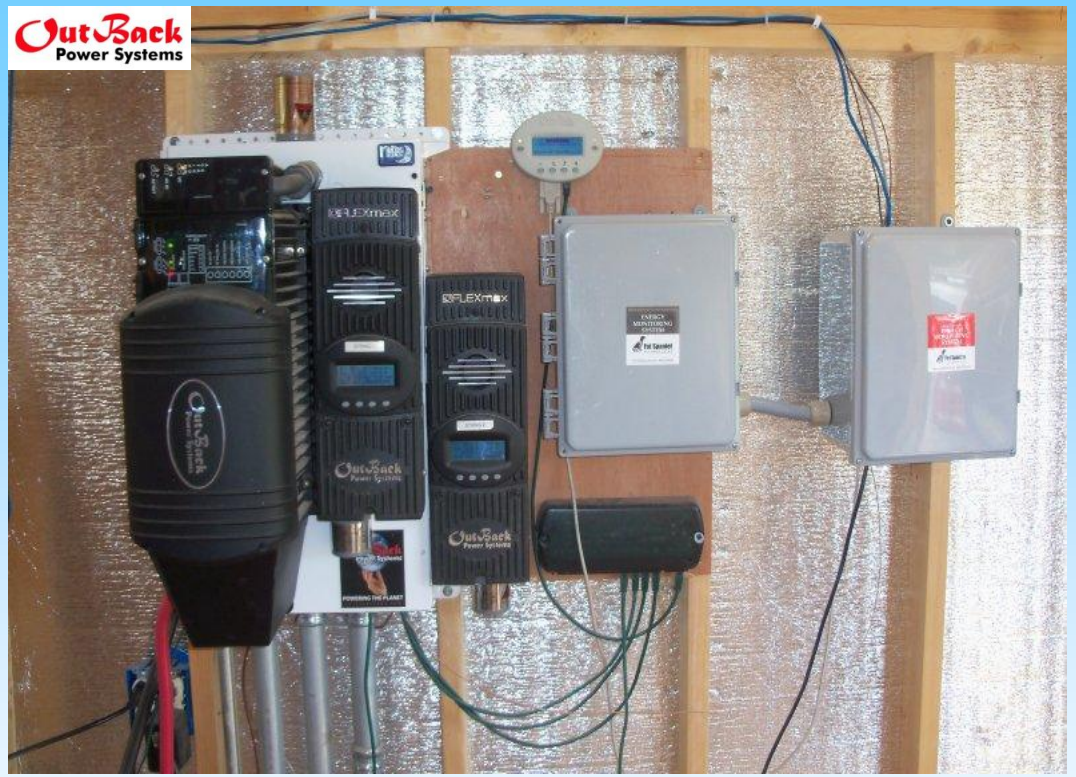
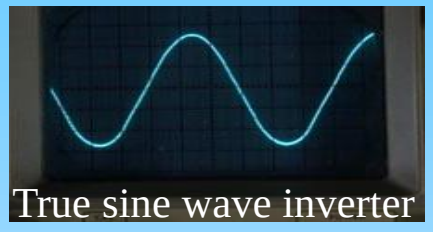
Residence on # 12 Laguna





True sine wave inverter

92% efficient
Maximum Power Point Controller MPPT

Built in Web Server
And weather station.

Remote Control

Deka

5 Year life
6Volts 370AH each
2 sets of 4 in series

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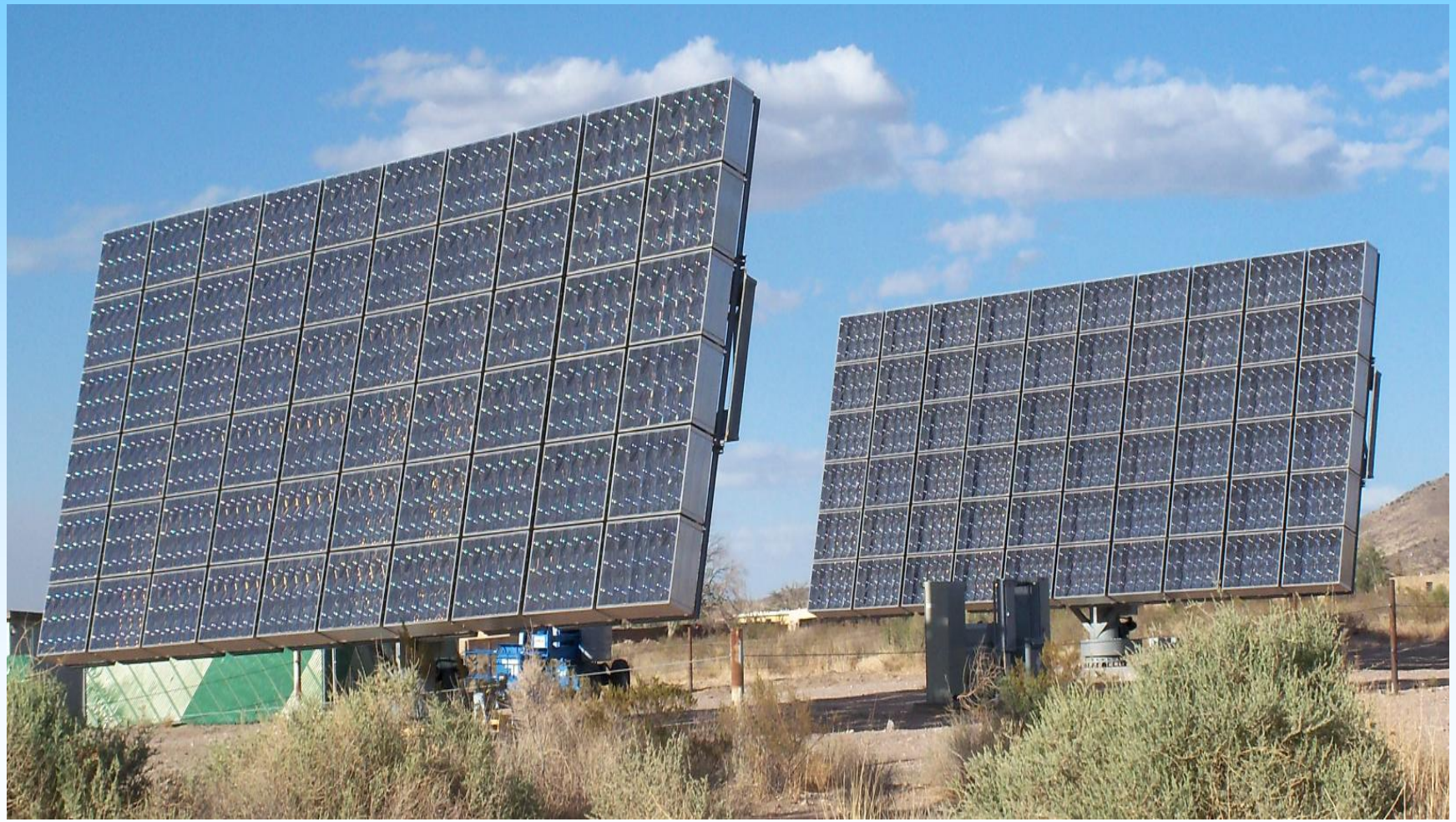
Bulk Energy Production 2 Each 25KW CPV Sun Tracking Arrays



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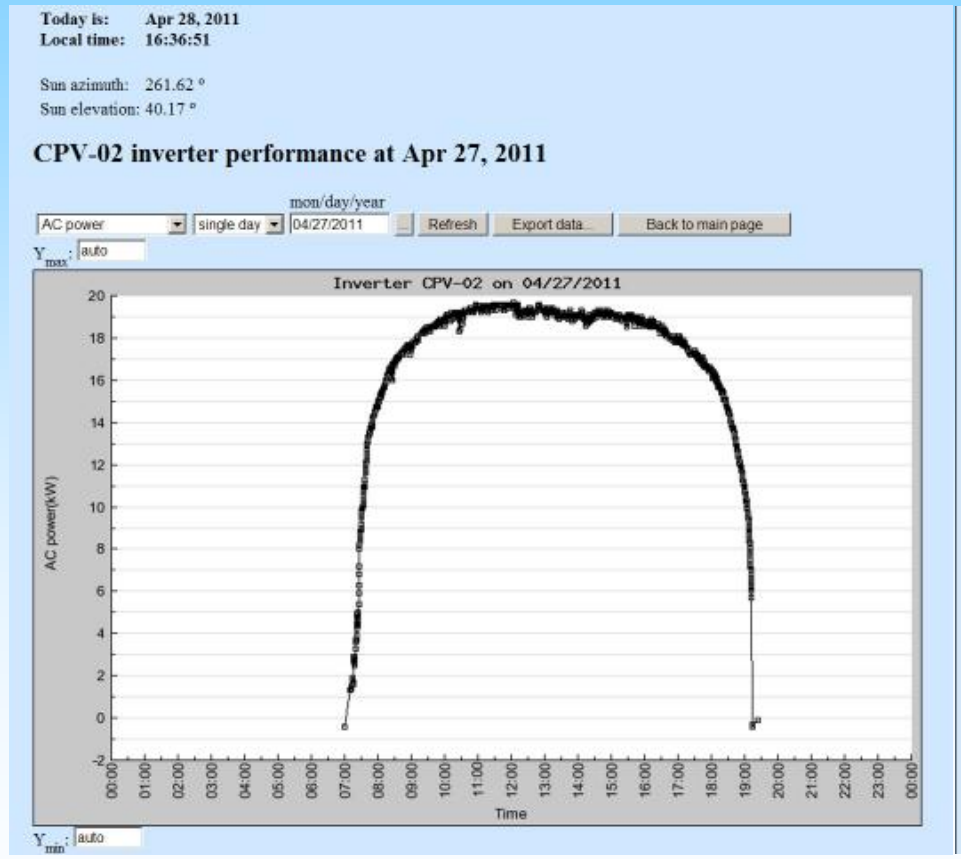
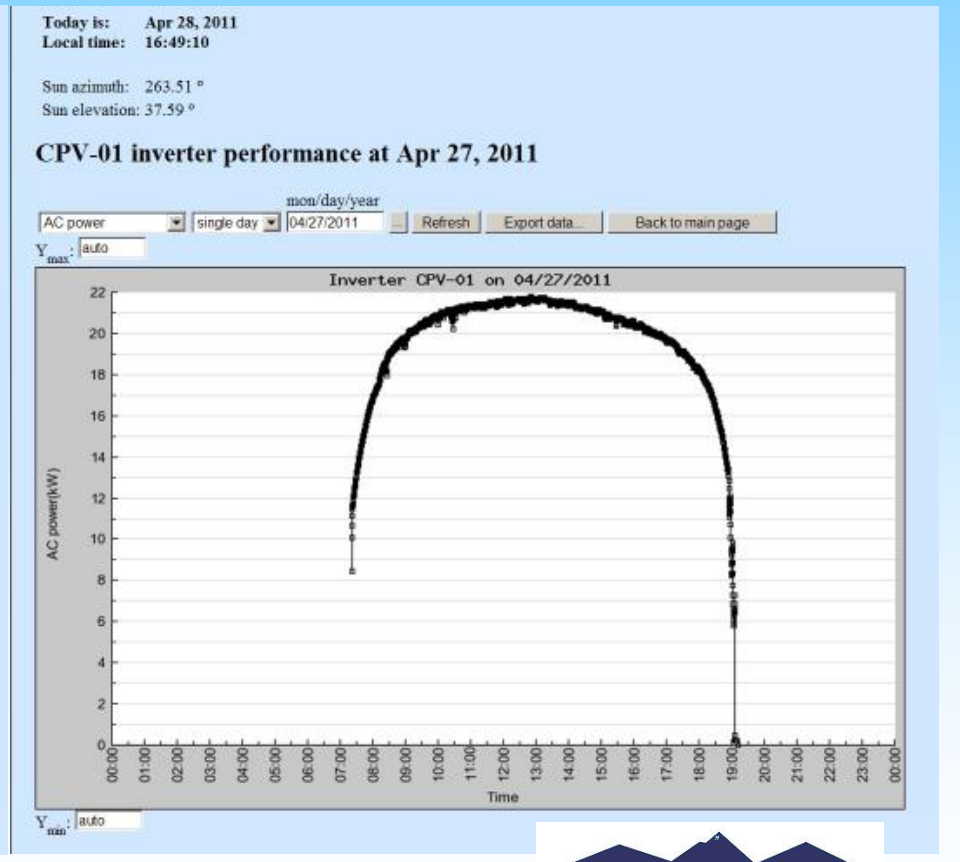
PV daily performance 24 Hrs





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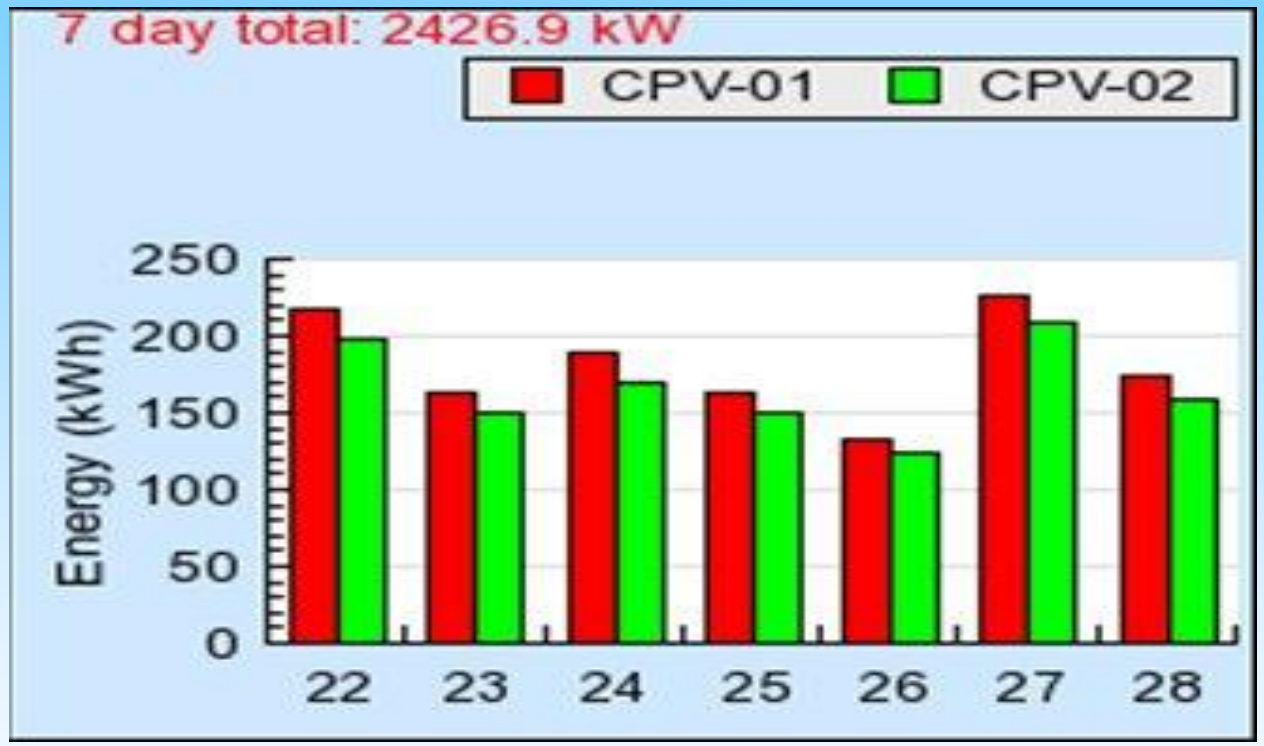
PV Weekly performance 2.4mW



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Inverter Testing

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Connection to Grid 50kW

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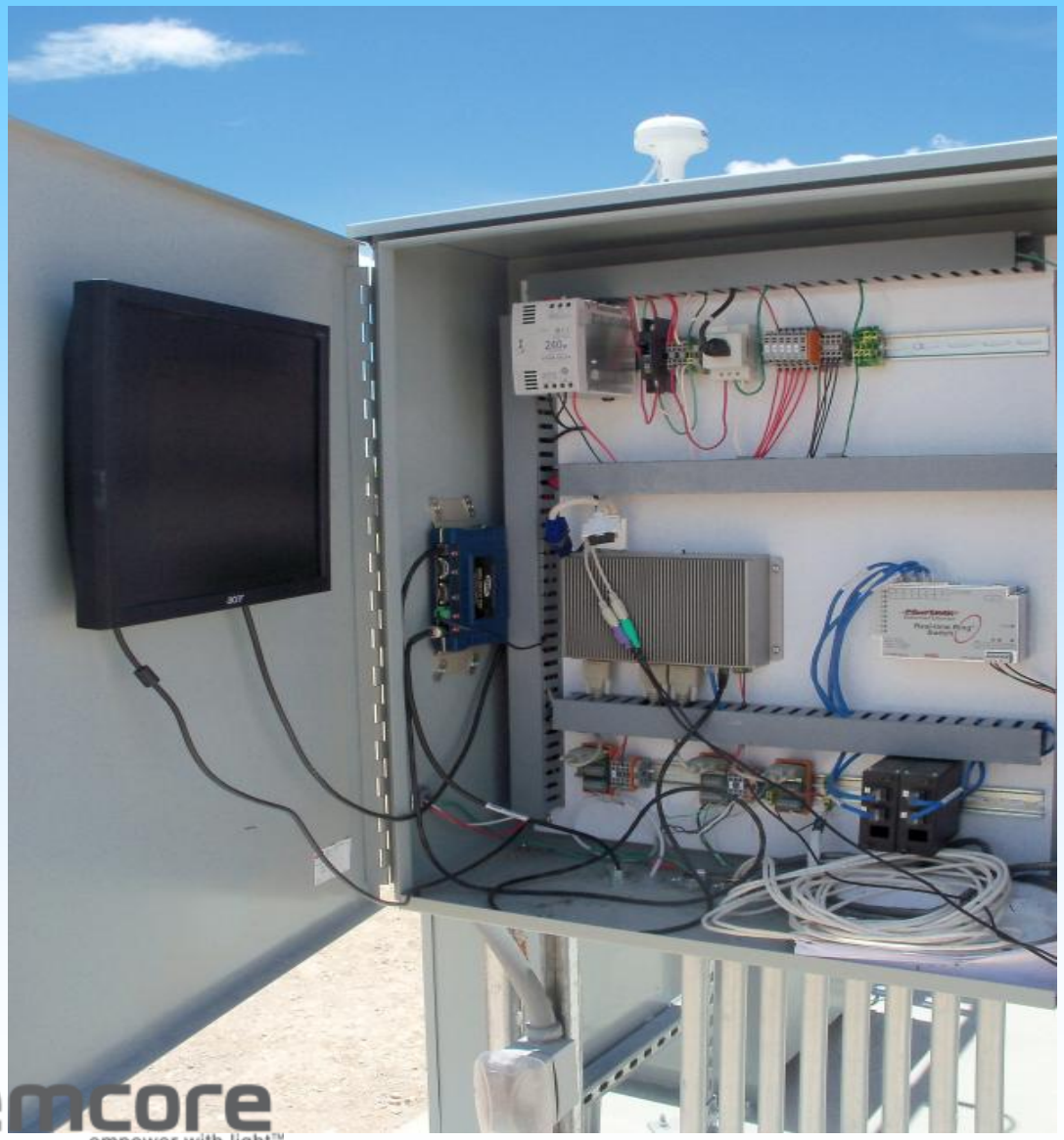
SCADA controls



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The need for Clean Power

Analyst Room

Command Room

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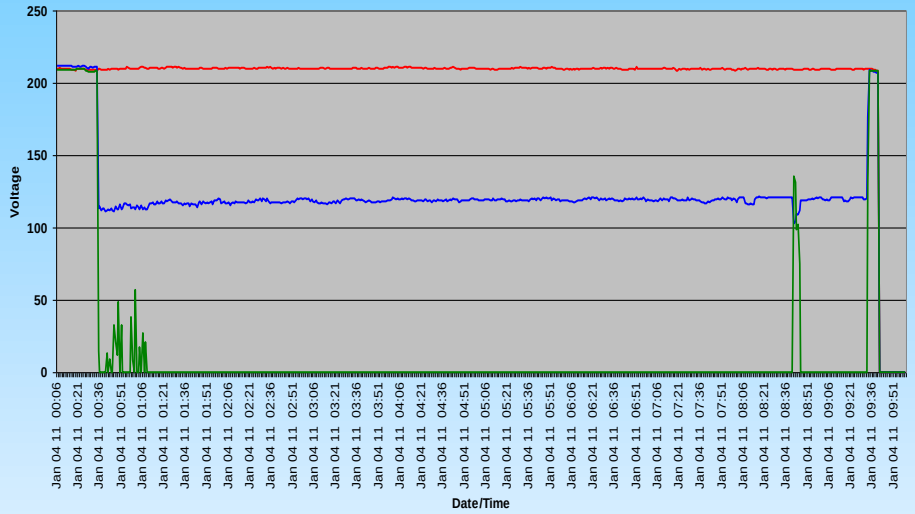
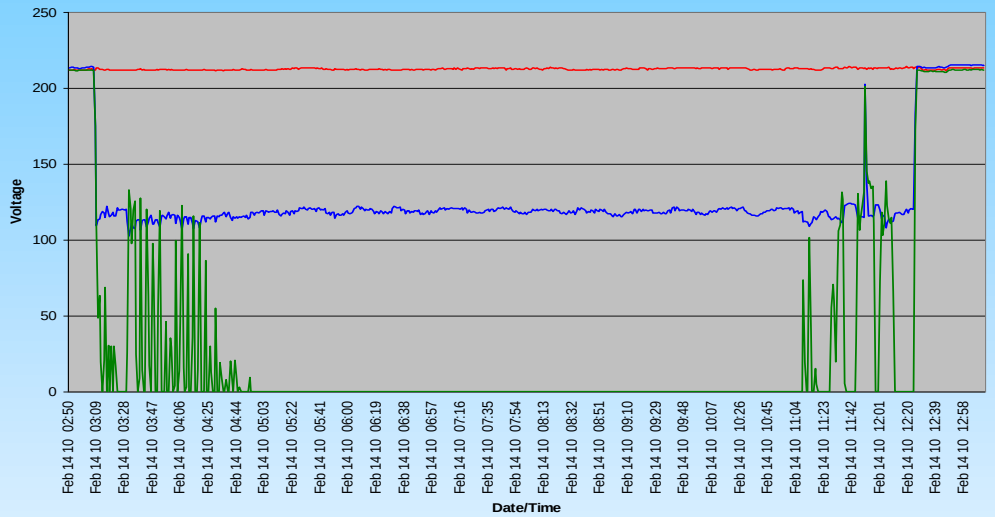
3 Phase utility outages destroys sensitive Equipment

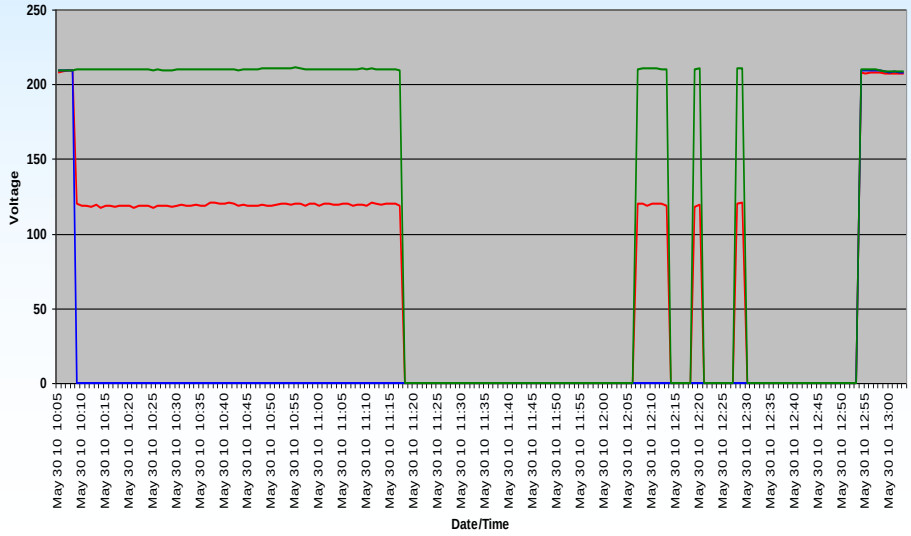
Payas Power Outage January 2011 (10hrs)



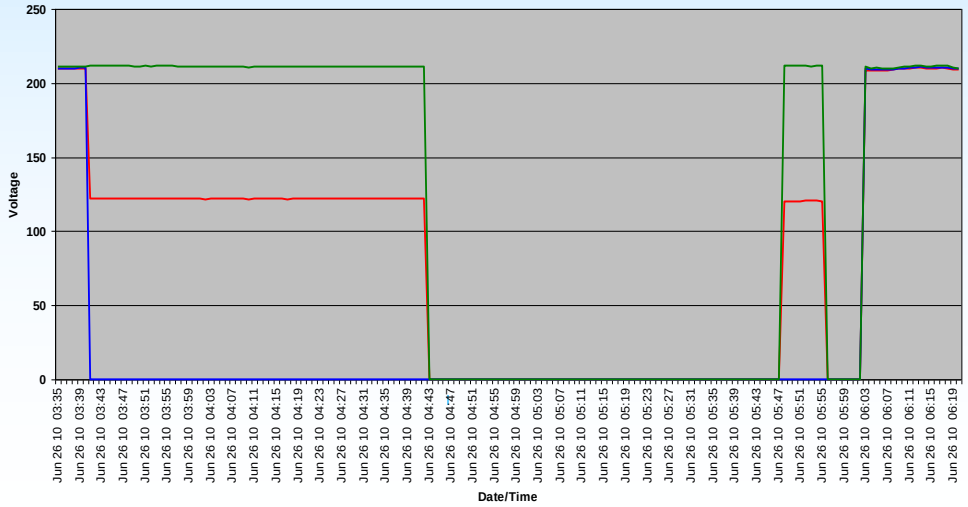
Playas Power Outage Feburary 2010 (10hrs)



Playas Power Outage May 2010 (3hrs)



Playas Power Outage June 2010 (3hrs)



Classroom Critical Power system

- System components are programmable interactive, grid connected with sell back capability and SCADA controls
- 18kW of 3 phase Clean uninterruptible power
- 36kW of surge capacity
- Subpanel feeds critical IT infrastructures and lighting
- 12.5kW of Solar PV Modules
- 72 kWhr of Absorbed Glass Matt batteries
- Uninterruptible Information Technology (IT) platform

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Playas Classroom 18 kW Critical Power system

Parking shade
With 120V outlets

Inverter Room
With SCADA

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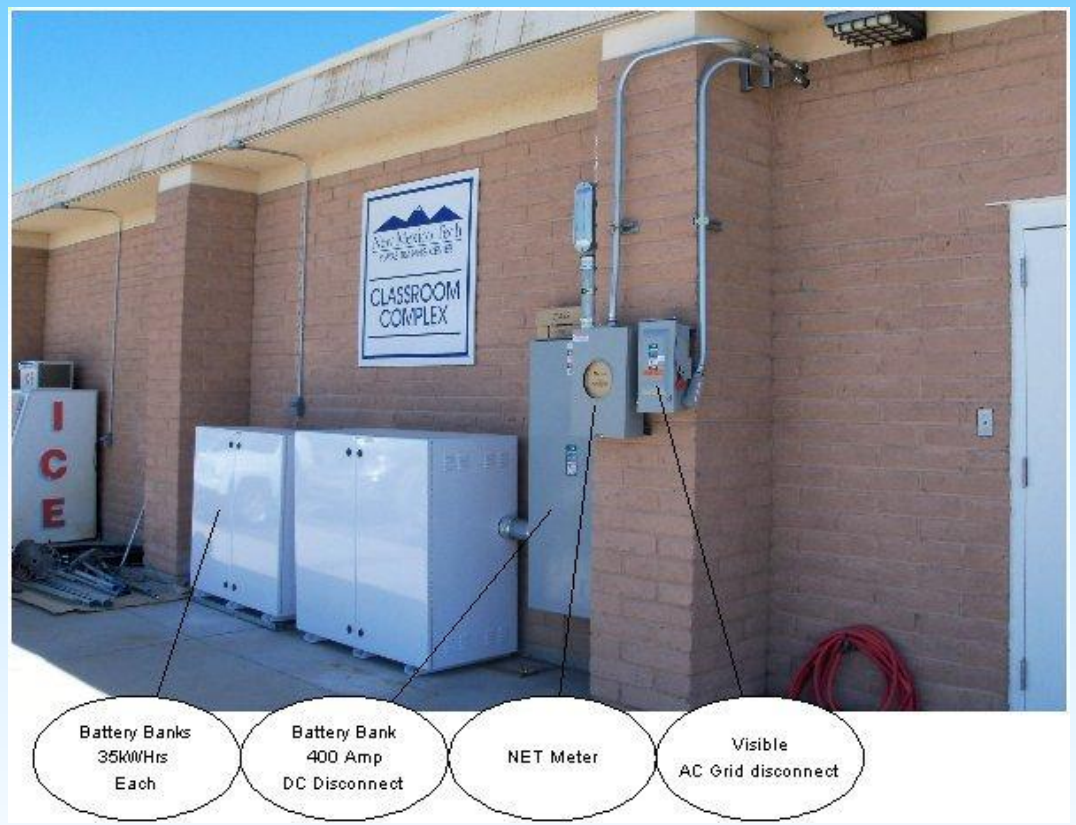
AGM Battery backup 72kWHrs



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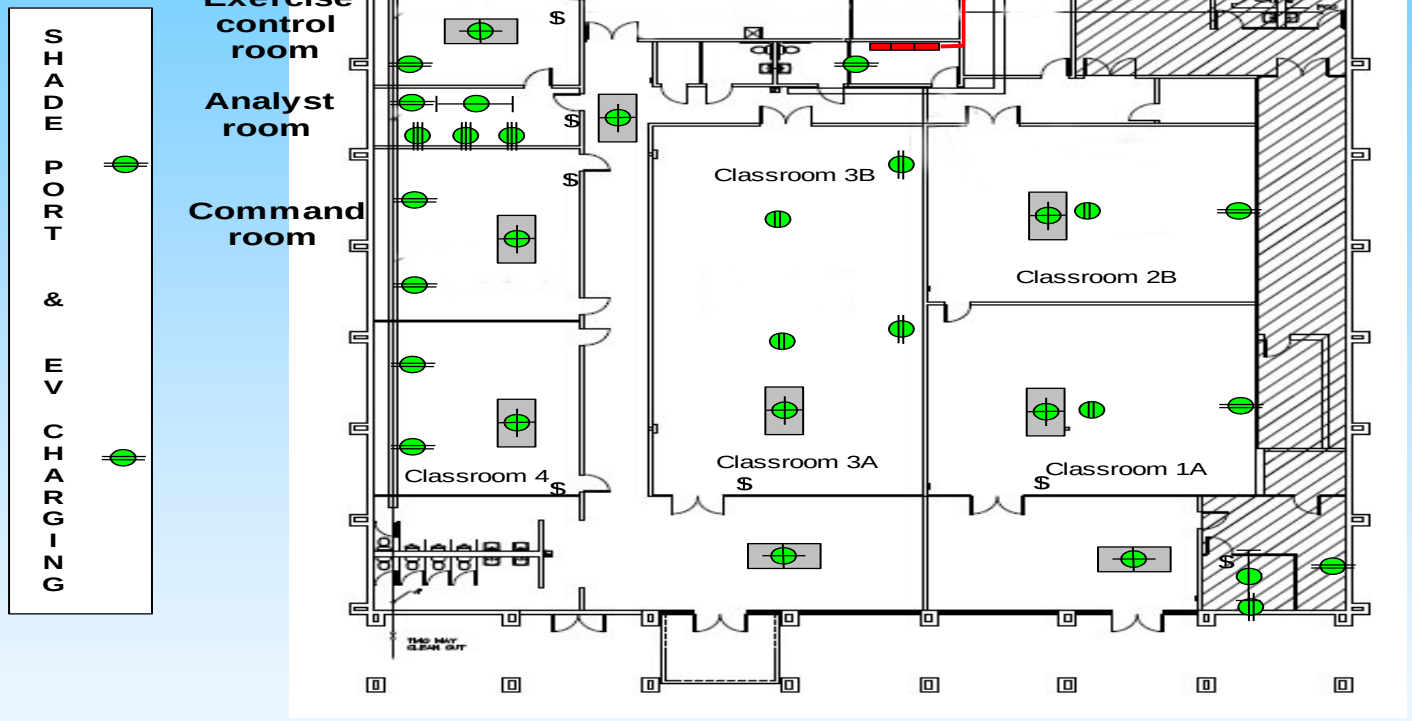
Classroom Critical loads



- Ceiling mount 120V outlets
- Wall mount 120Voutlets
- Wall mount 208V20A outlet
- Existing 2 lamp 2X4 fixture to be on PV sys W/retrofit
- Existing fixture to be on PV sys W/switch
- $ Wall mounted switch
- Bat Battery & DC Buss
- Inverter/Chargers

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Information Technology Command & Control Infrastructure

Hughes Satellite Internet Service Provider

Residence 10 Laguna 2.2kW PV
4kW Inverter 25kWhrs Storage

- Xantrex Inverter
- Xantrex Control Gateway
- Sat-Com Link
- Xantrex MPPT
- Router
- Xantrex MPPT
- SCADA COMPUTER
- Wireless Access point

Classroom 12.6kW PV
18kW 3 phase inverter 72kWhrs Strorage

- Remote Access Point
- Router
- NED Probe
- Digital Video Recorder
- Rooftop Camera
- IERA SCADA Computer
- Xantrex Control Gateway
- Xantrex Inverter
- Xantrex MPPT
- Playas Fiber Optic Modem
- Xantrex Inverter
- Xantrex MPPT
- Xantrex Inverter
- Xantrex MPPT

Residence 12 Laguna 2.2kW PV
3.6kW Inverter 16kWhrs storage

- Local PC
- Ethernet Switch
- Remote Access Point
- Outback Inverter
- Outback Control Gateway
- Outback MPPT
- Outback Hub-10
- Weather Gateway
- Outback MPPT

Emcore 50kW PV 3 phase grid tie

- Remote Access Point
- GPS Satellite Receiver
- Weather Station
- Emcore SCADA Computer
- Ethernet Ring Buss
- Tracker Motor Drive
- PV Powered Inverter
- Tracker Motor Drive
- Satcon

Valley Telephone underground fiber optic network

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12.6kW Solar Array

Shade-Carport with Electric Vehicle Charging and LED lighting

18kW 3-Phase Inverter with Intelligent controls

72kWHrs of Battery Backup

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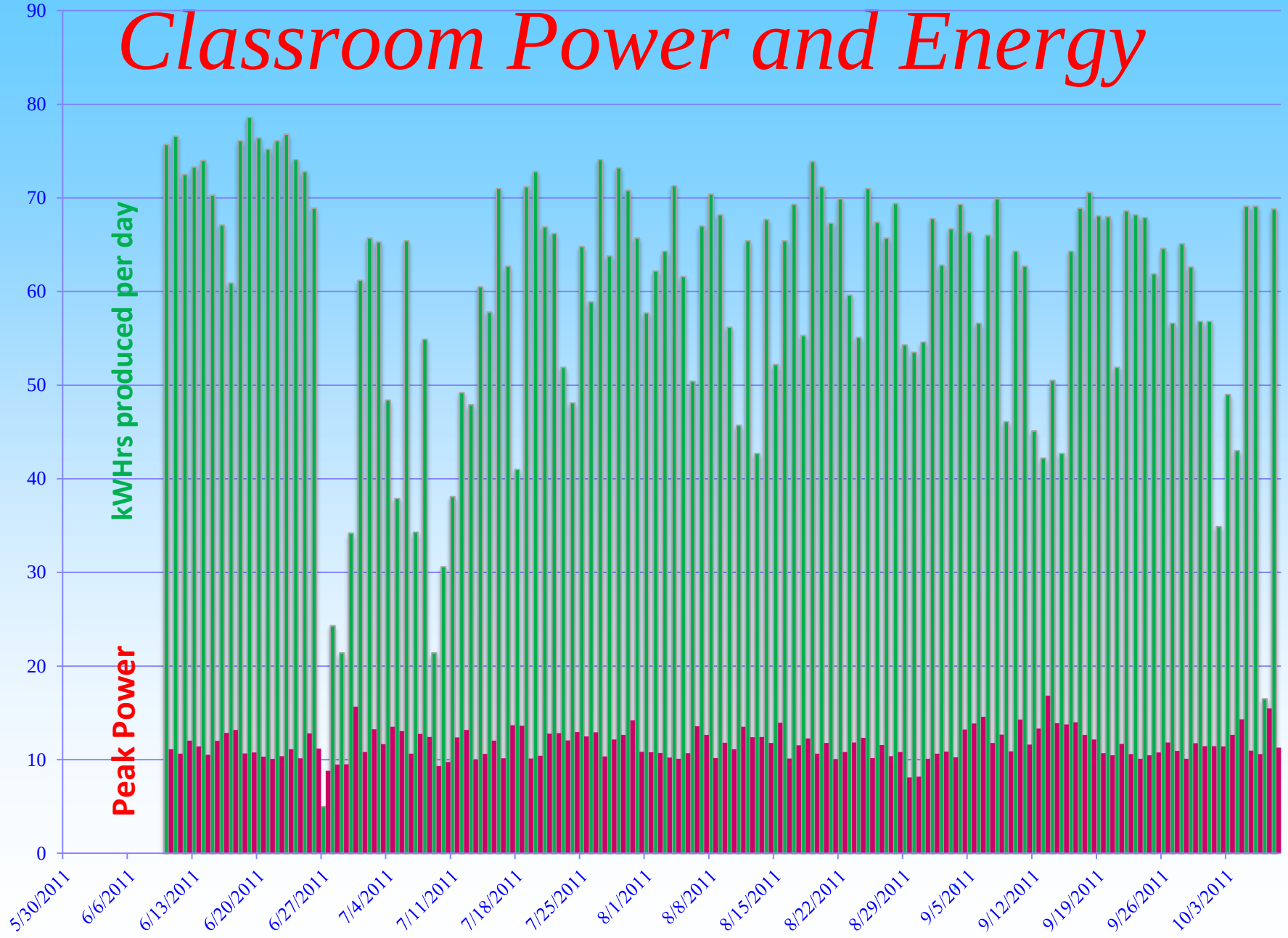
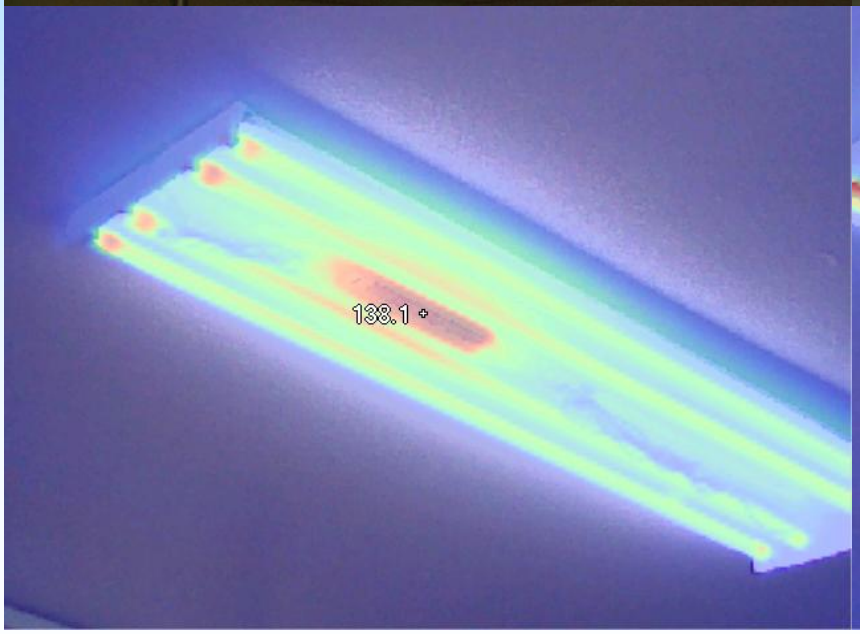
Classroom Power and Energy

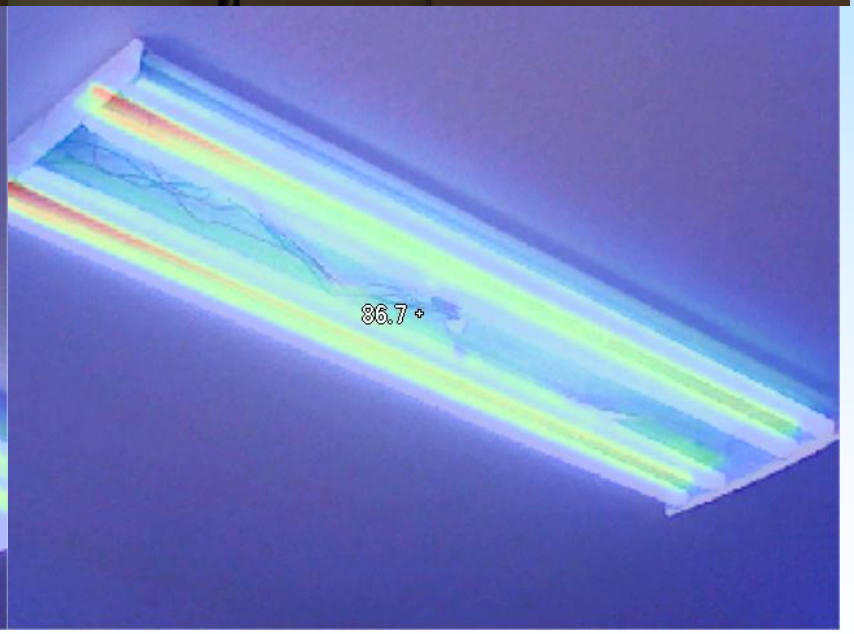


Energy Use Reduction

LEDs 50% Less Energy 25% more light

4 Foot Fluorescent/Ballast VS LED





160 Watts 70.6 Foot Candles

72 Watts 79.6Foot Candles

Incandescent VS LED

44 Lamps replaced 11,000 Watts VS 660 watts = 94% savings

250Watt Tungsten Halogen

15Watt LED

25X Longer 16.6X Less Energy

Lighting Upgrade at Community Center

8 Foot Fluorescent/Ballast VS LED

120 Watts 35.9 Foot Candles

60 Watts 58.2 Foot Candles

Conclusions

- Lessons learned from working with a local co-op
- 4 PV systems installed (add on capable)
- Potential renewable energy credits
- NMT owned systems that can be sued for research and data collection
- Data availability
- Demonstrated energy savings in lighting and heat loads
- Secure reliable systems possible through use of renewables